Photocouplers GaAℓAs Infrared LED & Photo IC

TLP2405

1. Applications

- High-Speed Digital Interfacing for Instrumentation and Control Devices
- Communications Equipment
- Intelligent Power Module Signal Isolation

2. General

The Toshiba TLP2405 consists of a GaAℓAs light-emitting diode coupled with a high-gain, high-speed photo detector. It is housed in the 8-pin SO8 package.

The detector has a totem-pole output stage with current sourcing and sinking capabilities.

The TLP2405 has an internal Faraday shield that provides a guaranteed common-mode transient immunity of ±15 kV/μs.

The TLP2405 a logic buffer output. An inverter output version, the TLP2408, is also available.

3. Features

(1) Buffer logic type (totem pole output)

(2) Package: SO8

(3) Supply voltage: 4.5 to 20 V

(4) Threshold input voltage, low to high: I_{FLH} = 1.6 mA (max)

(5) Propagation delay time: t_{pHL}/t_{pLH} = 250 ns (max)

(6) Common-mode transient immunity: ±15 kV/μs (min)

(7) Operating temperature: -40 to 100℃

(8) Isolation voltage: 3750 Vrms (min)

(9) Safety standard

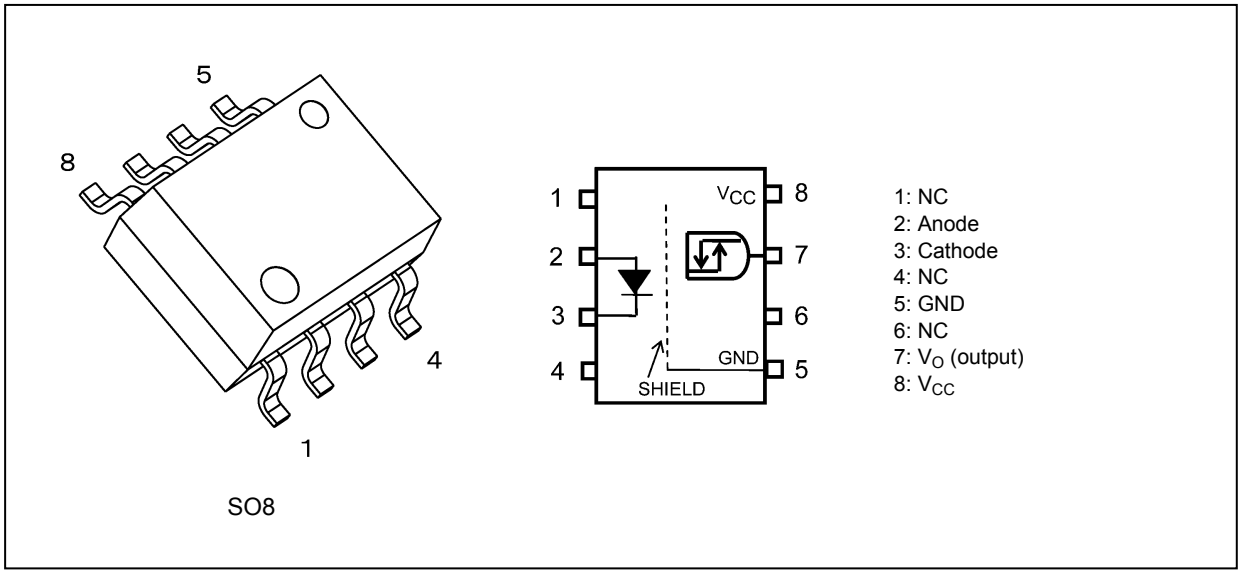
UL-approved: UL1577 File No.E67349

cUL-approved: CSA Component Acceptance Service No.5A, File No.E67349

VDE-approved: Option (V4) EN60747-5-2 **(Note)**

Note: When an EN60747-5-2 approved type is needed, please designate the **Option (V4)**.

4. Packaging and Pin Configuration



5. Internal Circuit (Note)

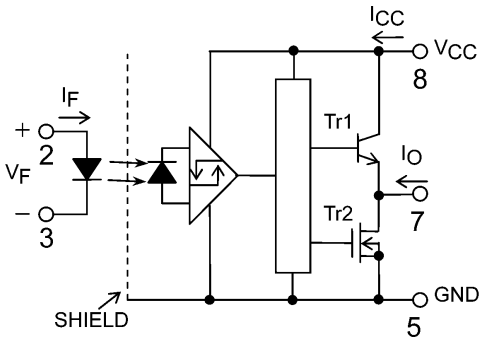


Fig. 5.1 Internal Circuit

Note: A 0.1-μF bypass capacitor must be connected between pin 8 and pin 5.

6. Principle of Operation

6.1. Truth Table

Input	LED	Output
H	ON	H
L	OFF	L

6.2. Mechanical Parameters

Characteristics	Min	Unit
Creepage distances	4.0	mm
Clearance	4.0	
Internal isolation thickness	—	

7. Absolute Maximum Ratings (Note)

Unless otherwise specified, T_a = 25°C

	Characteristics		Symbol	Note	Rating	Unit
LED	Forward current	($T_a \leq 85°C$)	I_F		25	mA
	Forward current derating	($T_a \geq 85°C$)	ΔI_F/°C		-0.67	mA/°C
	Reverse voltage		V_R		5	V
	Power dissipation		P_D		40	mW
	Power dissipation derating	($T_a \geq 85°C$)	ΔP_D/°C		-1.0	mW/°C
Detector	Output current	($T_a \leq 25°C$)	I_O		25/-15	mA
	Output current	(T_a = 100°C)	I_O		5/-5	
	Output voltage		V_O		-0.5 to 20	V
	Supply voltage		V_{CC}		-0.5 to 20	
Common	Operating temperature		T_{opr}		-40 to 100	°C
	Storage temperature		T_{stg}		-55 to 125	
	Lead soldering temperature	(10 s)	T_{sol}		260	
	Isolation voltage	AC, 1 min, R.H. ≤ 60%	BV_S	(Note 1)	3750	Vrms

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 1: This device is considered as a two-terminal device: Pins 1, 2, 3 and 4 are shorted together, and pins 5, 6, 7 and 8 are shorted together.

8. Recommended Operating Conditions (Note)

Characteristics	Symbol	Note	Min	Typ.	Max	Unit
Input on-state current	$I_{F(ON)}$		2	—	10	mA
Input off-state voltage	$V_{F(OFF)}$		0	—	0.8	V
Supply voltage	V_{CC}	(Note 1)	4.5	—	20	
Operating temperature	T_{opr}		-40	—	100	°C

Note: The recommended operating conditions are given as a design guide necessary to obtain the intended performance of the device. Each parameter is an independent value. When creating a system design using this device, the electrical characteristics specified in this datasheet should also be considered.

Note: A ceramic capacitor (0.1 μF) should be connected between pin 8 and pin 5 to stabilize the operation of a high-gain linear amplifier. Otherwise, this photocoupler may not switch properly. The bypass capacitor should be placed within 1 cm of each pin.

Note 1: Denotes the operating range, not the recommended operating condition.

9. Electrical Characteristics (Note)

Unless otherwise specified, T_a = -40 to 100°C, V_{CC} = 4.5 to 20 V

Characteristics	Symbol	Note	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Input forward voltage	V_F		—	I_F = 10 mA, T_a = 25°C	1.40	1.57	1.80	V
Input temperature coefficient of forward voltage	$\Delta V_F/\Delta T_a$		—	I_F = 10 mA	—	-1.8	—	mV/°C
Input reverse current	I_R		—	V_R = 5 V, T_a = 25°C	—	—	10	μA
Input capacitance	C_T		—	V = 0 V, f = 1 MHz	—	60	—	pF
Low-level output voltage	V_{OL}		Fig. 12.1.1	I_O = 3.5 mA, V_F = 0.8 V	—	0.2	0.6	V
High-level output voltage	V_{OH}	(Note 2)	Fig. 12.1.2	V_{CC} = 4.5 V, I_O = -2.6 mA, I_F = 5 mA	2.7	3.5	—	
				V_{CC} = 20 V, I_O = -2.6 mA, I_F = 5 mA	17.4	19	—	
Low-level supply current	I_{CCL}		Fig. 12.1.3	V_{CC} = 5.5 V, V_F = 0 V	—	—	3.0	mA
				V_{CC} = 20 V, V_F = 0 V	—	—	3.0	
High-level supply current	I_{CCH}		Fig. 12.1.4	V_{CC} = 5.5 V, I_F = 5 mA	—	—	3.0	
				V_{CC} = 20 V, I_F = 5 mA	—	—	3.0	
Low-level short-circuit output current	I_{OSL}	(Note 1)	Fig. 12.1.5	V_{CC} = V_O = 5.5 V, V_F = 0 V	15	80	—	
				V_{CC} = V_O = 20 V, V_F = 0 V	20	90	—	
High-level short-circuit output current	I_{OSH}	(Note 1)	Fig. 12.1.6	V_{CC} = 5.5 V, I_F = 5 mA, V_O = GND	-5	-15	—	
				V_{CC} = 20 V, I_F = 5 mA, V_O = GND	-10	-20	—	
Threshold input current, low to high	I_{FLH}		—	I_O = -2.6 mA, V_O > 2.4 V	—	0.4	1.6	
Threshold input voltage, high to low	V_{FHL}		—	I_O = 3.5 mA, V_O < 0.6 V	0.8	—	—	V
Input current hysteresis	I_{HYS}		—	V_{CC} = 5 V	—	0.05	—	mA

Note: All typical values are at T_a = 25°C.

Note 1: Duration of output short circuit time should not exceed 10 ms.

Note 2: $V_{OH} = V_{CC} - V_O$ (V)

10. Isolation Characteristics

Unless otherwise specified, T_a = 25°C

Characteristics	Symbol	Note	Test Conditions	Min	Typ.	Max	Unit
Capacitance (input to output)	C_S	(Note 1)	V_S = 0 V, f = 1 MHz	—	1.0	—	pF
Isolation resistance	R_S		V_S = 500 V, R.H. ≤ 60%	1×10^{12}	10^{14}	—	Ω
Isolation voltage	BV_S		AC, 1 min	3750	—	—	Vrms
			AC, 1 s in oil	—	10000	—	
			DC, 1 min in oil	—	10000	—	V_{DC}

Note 1: This device is considered as a two-terminal device: Pins 1, 2, 3 and 4 are shorted together, and pins 5, 6, 7 and 8 are shorted together.

11. Switching Characteristics (Note)

Unless otherwise specified, T_a = -40 to 100°C, V_{CC} = 4.5 to 20 V

Characteristics	Symbol	Note	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Propagation delay time to logic high output	t_{pLH}		Fig. 12.1.7, Fig. 12.1.8	I_F = 0 → 3 mA	30	90	250	ns
Propagation delay time to logic low output	t_{pHL}			I_F = 3 → 0 mA	30	120	250	
Pulse width distortion	$\|t_{pLH} - t_{pHL}\|$			—	—	—	220	
Rise time	t_r			I_F = 0 → 3 mA, V_{CC} = 5 V	—	30	75	
Fall time	t_f			I_F = 3 → 0 mA, V_{CC} = 5 V	—	30	75	
Common-mode transient immunity at output high	CM_H		Fig. 12.1.9	V_{CM} = 1000 V_{p-p}, I_F = 5 mA, V_{CC} = 20 V, T_a = 25°C	-15	—	—	kV/μs
Common-mode transient immunity at output low	CM_L			V_{CM} = 1000 V_{p-p}, I_F = 0 mA, V_{CC} = 20 V, T_a = 25°C	15	—	—	

Note: All typical values are at T_a = 25°C.

12. Test Circuits and Characteristics Curves

12.1. Test Circuits

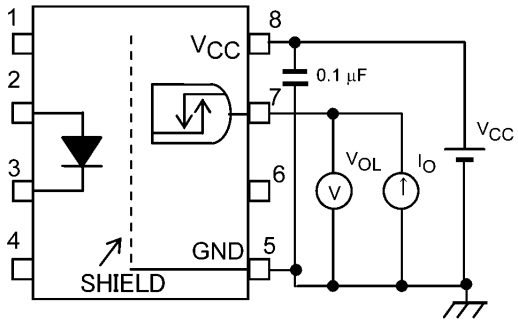


Fig. 12.1.1 V_{OL} Test Circuit

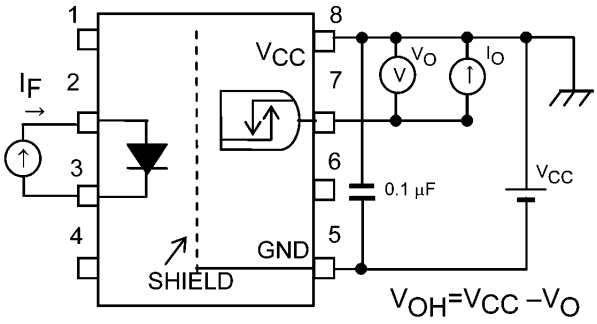


Fig. 12.1.2 V_{OH} Test Circuit

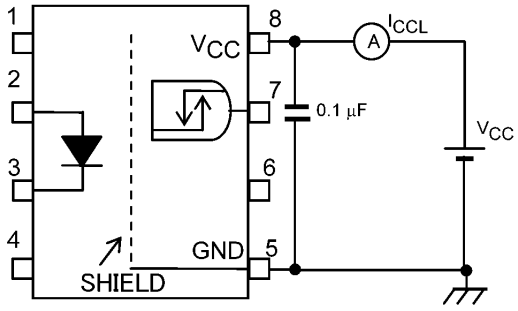


Fig. 12.1.3 I_{CCL} Test Circuit

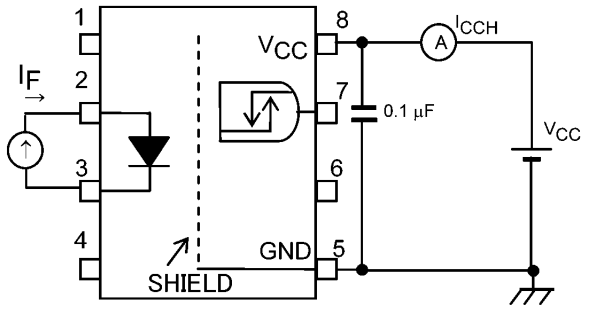


Fig. 12.1.4 I_{CCH} Test Circuit

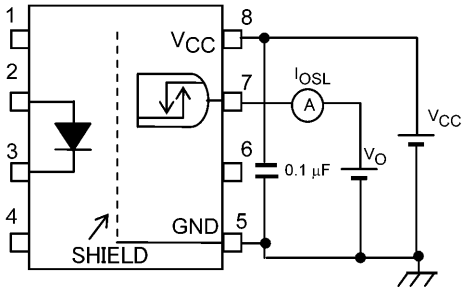


Fig. 12.1.5 I_{OSL} Test Circuit

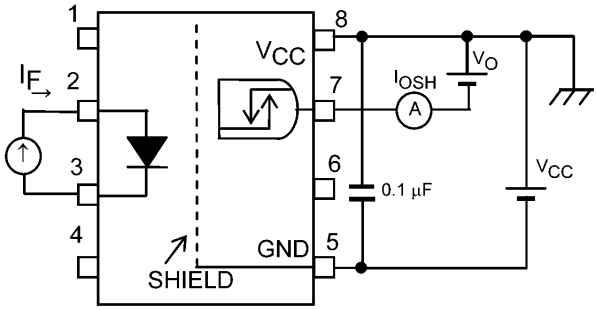
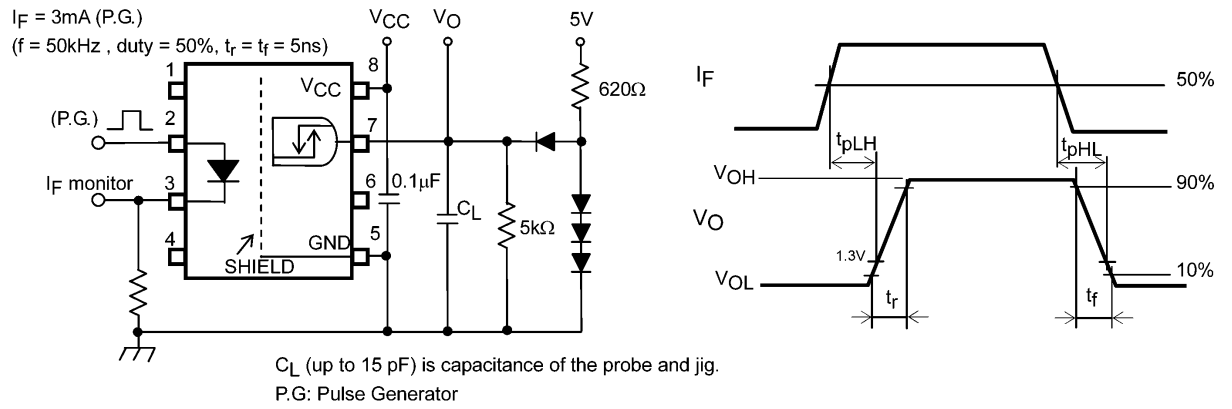
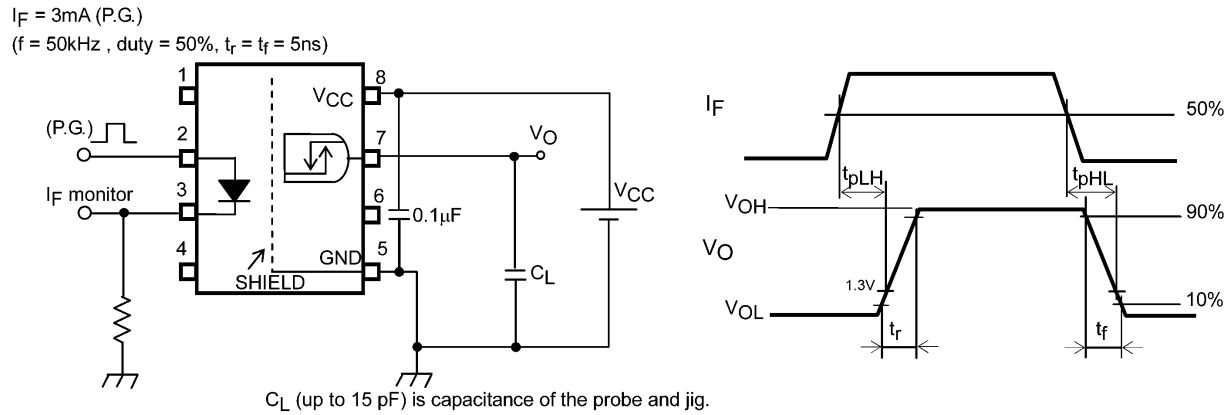


Fig. 12.1.6 I_{OSH} Test Circuit



CL (up to 15 pF) is capacitance of the probe and jig.
P.G: Pulse Generator

Fig. 12.1.7 Switching Time Test Circuit



CL (up to 15 pF) is capacitance of the probe and jig.
P.G: Pulse Generator

Fig. 12.1.8 Switching Time Test Circuit

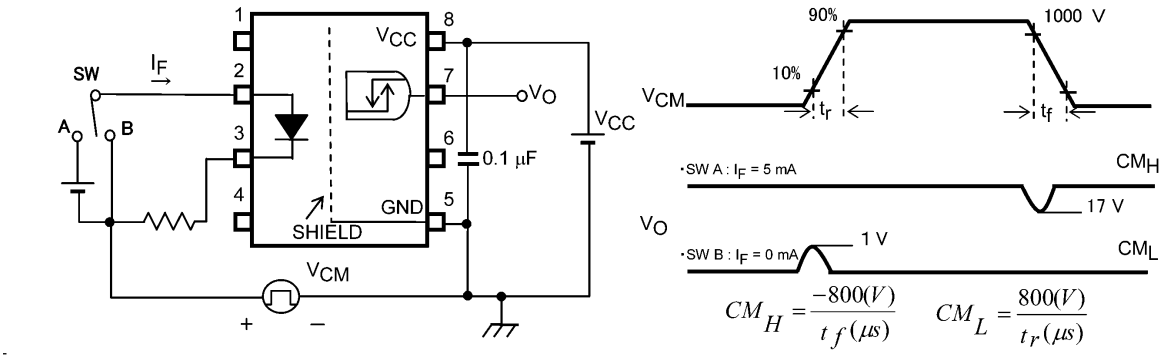


Fig. 12.1.9 Common-Mode Transient Immunity Test Circuit

13. Soldering and Storage

13.1. Precautions for Soldering

The soldering temperature should be controlled as closely as possible to the conditions shown below, irrespective of whether a soldering iron or a reflow soldering method is used.

- When using soldering reflow (See Fig. 13.1.1 and 13.1.2)
  Reflow soldering must be performed once or twice.
  The mounting should be completed with the interval from the first to the last mountings being 2 weeks.

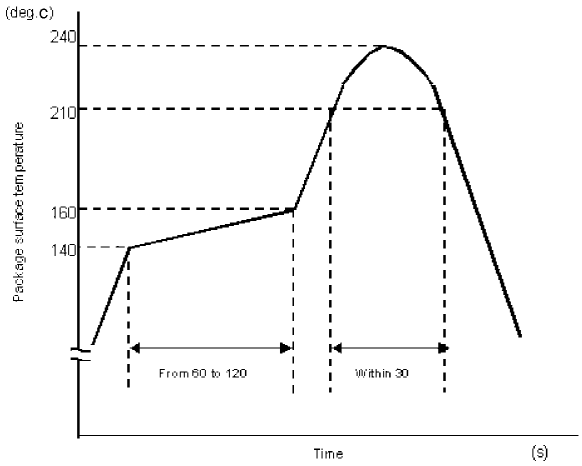


Fig. 13.1.1 An example of a temperature profile when Sn-Pb eutectic solder is used

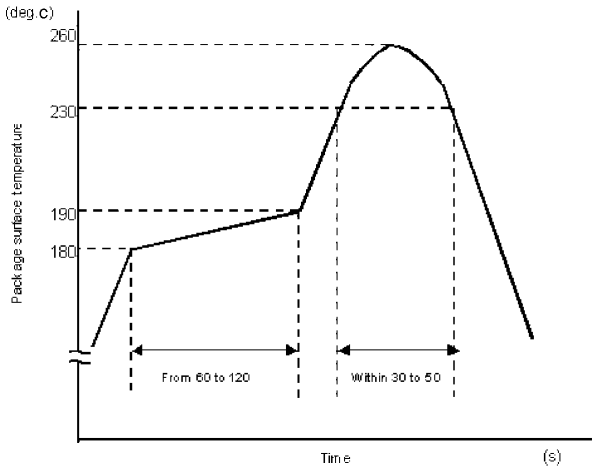


Fig. 13.1.2 An example of a temperature profile when lead(Pb)-free solder is used

- When using soldering flow (Applicable to both eutectic solder and Lead(Pb)-Free solder)
  Apply preheating of 150℃ for 60 to 120 seconds.
  Mounting condition of 260℃ within 10 seconds is recommended.
  Flow soldering must be performed once.
- When using soldering Iron (Applicable to both eutectic solder and Lead(Pb)-Free solder)
  Complete soldering within 10 seconds for lead temperature not exceeding 260℃ or within 3 seconds not exceeding 350℃
  Heating by soldering iron must be done only once per lead.

13.2. Precautions for General Storage

- Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Keep the storage location temperature and humidity within a range of 5℃ to 35℃ and 45% to 75%, respectively.
- Do not store the products in locations with poisonous gases (especially corrosive gases) or in dusty conditions.
- Store the products in locations with minimal temperature fluctuations. Rapid temperature changes during storage can cause condensation, resulting in lead oxidation or corrosion, which will deteriorate the solderability of the leads.
- When restoring devices after removal from their packing, use anti-static containers.
- Do not allow loads to be applied directly to devices while they are in storage.
- If devices have been stored for more than two years under normal storage conditions, it is recommended that you check the leads for ease of soldering prior to use.

14. Land pattern dimensions for reference only

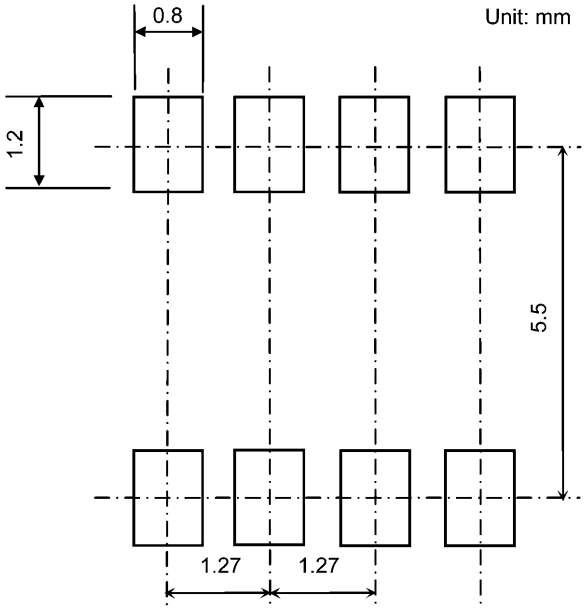


Fig. 14.1 Land pattern dimensions for reference only

15. Marking

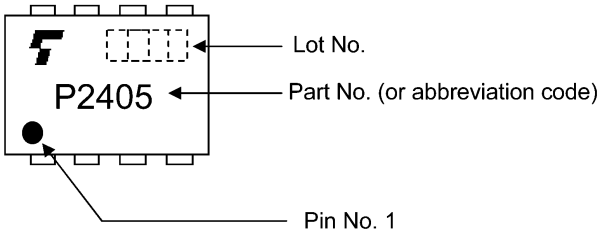


Fig. 15.1 Marking

16. EN60747-5-2 Option (V4) Specification

- Part number: TLP2405(F) **(Note)**
- The following part naming conventions are used for the devices that have been qualified according to option (V4) of EN60747.

  Example: TLP2405(V4-TPL,F)
  V4: EN60747 option
  TPL: tape and reel type
  F:[[G]]/RoHS COMPATIBLE **(Note 1)**

Note: Use TOSHIBA standard type number for safety standard application.
e.g., TLP2405(V4-TPL,F) → TLP2405

Note 1: Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.
RoHS is the Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronics equipment.

Description	Symbol	Rating	Unit
Application classification for rated mains voltage ≤ 150Vrms for rated mains voltage ≤ 300Vrms		 I-IV I-III	—
Climatic classification		40 / 100 / 21	—
Pollution degree		2	—
Maximum operating insulation voltage	V_{IORM}	565	Vpk
Input to output test voltage, Method A Vpr=1.5 × V_{IORM}, type and sample test tp=10s, partial discharge<5pC	V_{pr}	850	Vpk
Input to output test voltage, Method B Vpr=1.875 × V_{IORM}, 100% production test tp=1s, partial discharge<5pC	V_{pr}	1060	Vpk
Highest permissible overvoltage (transient overvoltage, tpr=60s)	V_{TR}	6000	Vpk
Safety limiting values (max. permissible ratings in case of fault, also refer to thermal derating curve) current (input current I_F, Pso=0) power (output or total power dissipation) temperature	 I_{si} P_{so} T_s	 250 400 150	 mA mW °C
Insulation resistance V_{IO}=500V, Ta=T_s	R_{si}	$\geq 10^9$	Ω

Fig. 16.1 EN60747 Insulation Characteristics

Minimum creepage distance	Cr	4.0mm
Minimum clearance	Cl	4.0mm
Minimum insulation thickness	ti	–
Comparative tracking index	CTI	175

Fig. 16.2 Insulation Related Specification (Note)

Note: If a printed circuit is incorporated, the creepage distance and clearance may be reduced below this value. (e. g., at a standard distance between soldering eye centres of 3.5mm). If this is not permissible, the user shall take suitable measures.

Note: This photocoupler is suitable for **safe electrical isolation** only within the safety limit data. Maintenance of the safety data shall be ensured by means of protective circuits.

VDE test sign : Marking on product for EN60747 V

: Marking on packing for EN60747 VDE

Marking Example : TLP2405(F)

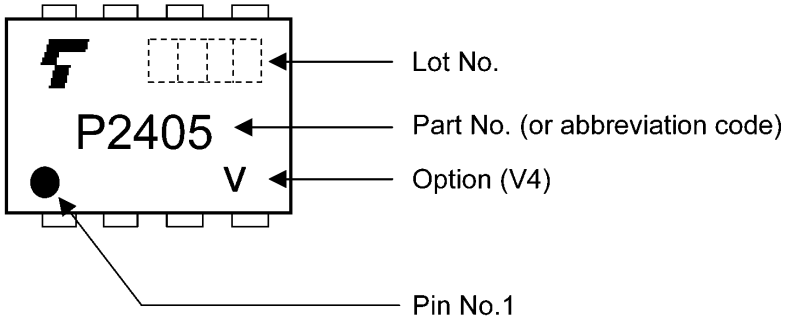


Fig. 16.3 Marking Example (Note)

Note: The above marking is applied to the photocouplers that have been qualified according to option (V4) of EN60747.

Figure 1 Partial discharge measurement procedure according to EN60747
Destructive test for qualification and sampling tests.

Method A

(for type and sampling tests, destructive tests)

t_1, t_2	= 1 to 10 s
t_3, t_4	= 1 s
t_p(Measuring time for partial discharge)	= 10 s
t_b	= 12 s
t_{ini}	= 60 s

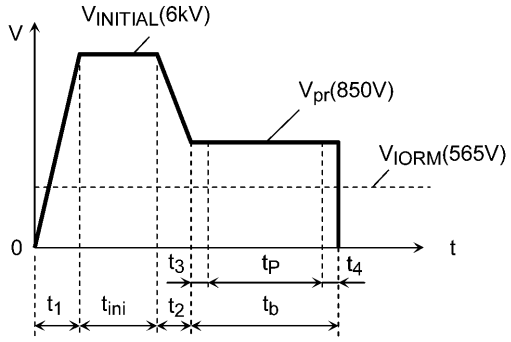


Figure 2 Partial discharge measurement procedure according to EN60747
Non-destructive test for100% inspection.

Method B

(for sample test,non-destructive test)

t_3, t_4	= 0.1 s
t_p(Measuring time for partial discharge)	= 1 s
t_b	= 1.2 s

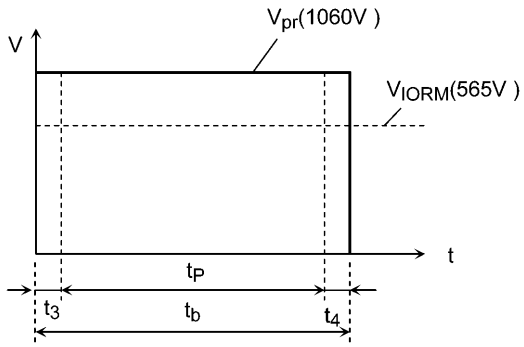


Figure 3 Dependency of maximum safety ratings on ambient temperature

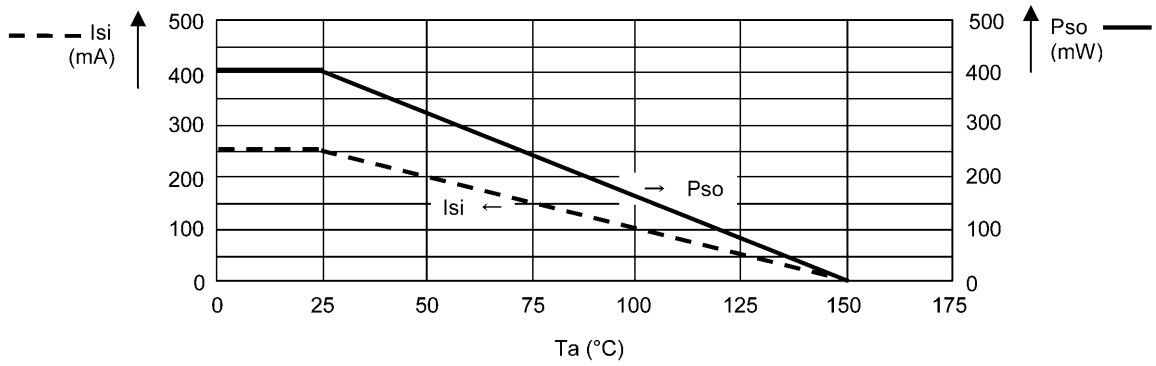
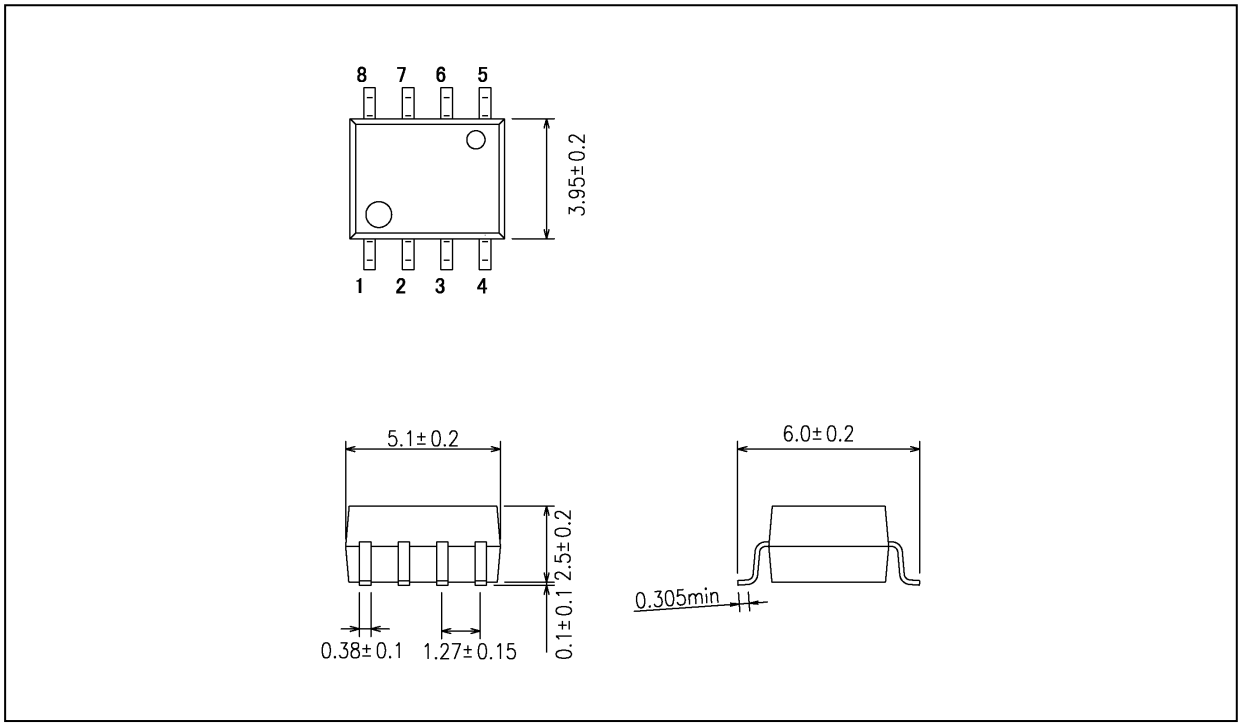


Fig. 16.4 Test Results

Package Dimensions

Unit: mm



Weight: 0.11 g (typ.)

Package Name(s)
TOSHIBA: 11-5K1S
Nickname: SO8

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